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ABSTRACT

An audiometric screening survey was conducted on a severely and profoundly mentally retarded population using noise-makers and pure tone audiometry. Of those tested with noise-makers, 83% gave an identifiable response to sound, 7% did not respond, and 10% were considered difficult-to-test. By contrast, 4% passed, 2% failed, and 94% were difficult-to-test using the audiometer. The resultant data were further analyzed as to age, sex, and medical classification. Females tended to be less responsive and more difficult-to-test. The age range 10-19 years appeared to be a critical period for responsiveness. It was concluded that audiometric methods other than standard pure tone audiometry would probably be better for a severely and profoundly retarded population. (Author)

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IDENTIFICATION AUDIOMETRY IN AN INSTITUTIONALIZED SEVERELY AND PROFOUNDLY MENTALLY RETARDED POPULATION[1]

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Introduction

An audiometric screening survey was conducted on a severely and profoundly mentally retarded population using noise-makers and pure tone audiometry. Of those tested with noise-makers, 83% gave an identifiable response to sound, 7% did not respond, and 10% were considered difficult-to-test. By contrast, 4% passed, 2% failed, and 94% were difficult-to-test using the audiometer. The resultant data was further analyzed as to age, sex, and medical classification. Females tended to be less responsive and more difficult-to-test. The age range 10-19 years appears to be a critical period for responsiveness. It is concluded that audiometric methods other than standard pure tone audiometry would probably be better for a severely and profoundly retarded population.

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The phases of the hearing program at Central Wisconsin Colony (CWC) are: (1) Identification, (2) Diagnoses, (3) Habilitation, and (4) Follow-up. The Speech and Hearing Research Department at CWC is charged with the responsibility of providing basic research in these areas. Since the mentally retarded (MR) as a group has been reported as having a higher incidence of hearing loss (See Lloyd and Frisina, 1965, Appendix C), and there was a need to identify the incidence of hearing loss at CWC so that clinical and research activities could be initiated in the above areas, an audiometric screening survey was conducted.

Procedure

Subject Selection

Out of a total population of 1069, 1044 residents were screened in the initial survey. They range in chronological age (CA) from three months to 67 years with 82% of the population falling below 25 years of age. All total, 542 males and 502 females were seen. This population has a 93% representation in the severely and profoundly retarded categories (re: Heber, 1961). Thirty-one percent are ambulatory with the remaining 69% being either semi- or non-ambulatory. Approximately 90% have no meaningful speech and approximately 69% cannot follow simple directions. Fifteen percent of the residents are listed as being "generally cooperative". Adaptive behavior levels at CWC are rated according to the Heber classification and by the CWC Scales of Adaptive Behavior (Balthazar, E., et al, 1968). The scales have been used on ambulant patients only and ratings are still in progress; consequently, no attempt has been made in this report to

relate the audiometric findings to an "adaptive behavior level".

Test Environment

The screening tests were conducted either on the ward or in the quietest area off the ward. Testing was conducted from approximately 1:00 to 2:30 P.M. This represents the time when most patients are awakening from noon naps and is approximately two hours following the noon meal. Indirect lighting is used on most of the wards; temperature fluctuates from approximately 74 to 92 degrees during the summer months with the humidity ranging from approximately 50 to 90%. Ambient noise levels were from 46 to 62 dB SPL as measured on the A weighting network of a sound level meter (B & K, Type 2203).

Equipment

A pure-tone audiometer (Beltone, Model 10C, equipped with TDH 39 earphones and MX41/AR cushions) was used with those patients that were four years of age and older. Noise-makers were used with all patients.

Characteristics of Noisemakers

Several noise-makers (See Table 1) were used initially so as to obtain an indication of which one(s) was most effective in eliciting a response. While no formal statistical tabulation was made, it was observed initially that the lamb, guitar, and large cowbell were superior in eliciting responses. Therefore, these three noise-makers were used throughout the survey. Residents were classified according to whether they "responded", "did not respond", or were "difficult-to-test". In other words, no resident was considered as having "passed" or "failed" according to responses or lack of responses to the noise-makers.

TABLE I.

Noisemakers	*Sound Pressure Level (SPL)	*Frequency Response (Hz)
Squeak Toys		
Lamb	90 dB	800 - 4200
Guitar	95 dB	700 - 4300
Accordion	90 dB	2500 - 5000
Rattle	94 dB	4500 - 10,000
Small Bells	83 dB	3000 - 5000
Large Cowbell	102 dB	600 - 10,000
Medium Cowbell	100 dB	900 - 8000
Small Cowbell	104 dB	1200 - 5000

*Measurements obtained with B & K Audio Frequency Spectrometer, Type 2112 (1/3 octave), and B & K Sound Level Meter, Type 2203, one foot from microphone with Zero degree incidence.

However, the use of these noise-makers did give an indication of this population to gross sounds of relatively high intensity and of a broad frequency spectrum.

Responses Observed to Noise-makers

Several motor responses were observed. Not all of the responses were seen in any one patient. These responses were: (1) eyeblinks, (2) eye quivering, (3) frowns, (4) laughs, (5) crying, (6) Moro reflex, (7) startle reflex, (8) sucking activity, (9) increased neck tension, (10) lateral eye movement, (11) localization (head, eyes, and body turning), (12) movement of one or more extremities, (13) arousal, (14) orienting, and (15) change in respiration.

Screening Procedure with Audiometer

The frequencies 1000, 2000, 4000, and 500 were used, in that order, at a level of 10 dB (ASA, 1951 standard). Lack of a response to one or more frequencies in both ears constituted a failure. The residents were brought to the test area and an explanation or a demonstration of the test protocol was given. If a resident did not understand what was expected of him, and the majority of the cases did not, an attempt at conditioning was made by raising his hand each time the tone was presented (initially at supra-threshold levels of 70-100 dB), by having him drop blocks in a basket, or by having him stack rings on a peg. Approximately five minutes were spent with each patient during this procedure.

Classification of Residents

Residents responding appropriately to all frequencies tested were classified as "Inactive"; those not responding to all frequencies

were classified as "Active"; and those who would not raise their hands or could not be conditioned, or simply refused to cooperate, were labeled as "difficult-to-test" (DTT), (Lloyd and Reid, 1967). Those residents who are "Inactive" are to be re-checked every two years. The "Active" and "Difficult-to-test" subjects are scheduled to receive complete audiometric evaluations using standard, modified ear-choice, play, tangible reinforcement operant conditioning audiometry (TROCA), and radio telemetric electroencephalographic response audiometry (Reneau and Mast, 1968). An otological examination and subsequent treatment by qualified otologists has been scheduled for all residents, regardless of their respective classification.

Results

Table II is a distribution by ward, sex, and test results for the noise-makers. As can be seen, 98% of the population were screened, with the other two percent either being off the ward (N = 13), usually on a home visit, or were not tested due to medical reasons (N = 12). A Chi square test (X^2) (Downie and Heath, 1959) computed between sex and test results is shown in Table III. This tabulation revealed a X^2 of 12.11, significant at the .01 level of confidence. In order to probe the nature of the significance, further statistical analysis revealed the difference to be for the "difficult-to-test" category, with females being more difficult to test than males ($P < .02$, 1df).

Table IV is a breakdown of the population as to age, sex, and test results. Only the age ranges having 10% or more of the population were used in the X^2 computation. Consequently, the age range 30-39 and 40 plus were not included in the statistical analysis.

TABLE II.

WARD	TOTAL POPULATION			NOT PRESENT			TOTAL SCREENED			RESPONDED			DID NOT RESPOND			DIFFICULT TO TEST			MEDICAL CONTRAINDICATIONS TO TESTING (MCT)		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Inf. 1	53	33	86	0	0	0	53	33	86	51	26	77	1	3	4	1	4	5	0	0	0
Inf. 2	55	44	99	0	0	0	55	44	99	50	36	86	2	3	5	3	5	8	0	0	0
Inf. 3	31	76	107	0	1	1	30	75	105	27	63	90	1	5	6	2	7	9	1	0	1
Inf. 4	104	0	104	2	0	2	101	0	101	77	0	77	10	0	10	14	0	14	1	0	1
Inf. 5	25	81	106	0	0	0	25	81	106	25	65	90	0	2	2	0	14	14	0	0	0
Inf. 6	49	49	98	0	0	0	49	49	98	46	42	88	2	5	7	1	2	3	0	0	0
Inf. 7	34	17	51	2	2	4	31	14	45	31	12	43	0	2	2	0	0	0	1	1	2
Inf. 8	55	56	111	1	0	1	52	55	107	46	32	78	0	10	10	6	13	19	2	1	3
I North	33	30	63	0	1	1	31	29	60	24	27	51	2	1	3	5	1	6	2	0	2
I South	20	13	33	0	0	0	20	13	33	16	12	28	3	1	4	1	0	1	0	0	0
II North	21	33	54	2	1	3	18	32	50	13	18	31	1	6	7	4	8	12	1	0	1
II South	17	7	24	0	0	0	17	7	24	14	4	18	2	1	3	1	2	3	0	0	0
III North	20	24	44	0	0	0	20	23	43	18	21	39	1	0	1	1	1	2	0	1	1
III South	11	7	18	0	0	0	11	7	18	11	4	15	0	1	1	0	2	2	0	0	0
IV North	14	27	41	0	1	1	14	26	40	9	22	31	3	2	5	2	2	4	0	0	0
IV South	15	15	30	0	0	0	15	14	29	14	11	25	1	1	2	0	2	2	0	1	1
Totals	557	512	1069	7	6	13	97% 542	98% 502	98% 1044	87% 472	78% 396	83% 868	5% 29	9% 43	7% 72	8% 41	13% 63	10% 104	8	4	12

TABLE III.

Variables	df	X^2	Level of Significance	N M	N F	N Total
ex X Test Results	2	12.11	.01	542	502	1044
Responses	1	1.16	NS	472	396	868
No Responses	1	3.56	NS	29	43	72
DTT	1	5.54	.02	41	63	104

TABLE IV.

Age	Total Screened			Responded			Did Not Respond			Difficult To Test		
	M	F	T	M	F	T	M	F	T	M	F	T
0-3	50	50	100	43	40	83	3	4	7	4	6	10
4-9	200	171	371	172	138	310	13	14	27	15	19	34
10-19	175	155	330	158	122	280	3	13	16	14	20	34
20-29	87	77	164	74	59	133	7	6	13	6	12	18
30-39	22	29	51	19	24	43	2	4	6	1	1	2
40+	8	20	28	6	13	19	1	2	3	1	5	6
Totals	542	502	1044	472	396	868	29	43	72	41	63	104

Table V shows the results of the X^2 computed for the remaining four age groups. Only the 10-19 year age group reached a level of significance ($P < .01$, 2 df). Further statistical analysis revealed the significance to be for the "no response" category, with females being less responsive than males.

A distribution by medical classification (Heber, 1961), sex, and test results is revealed in Table VI. Those classifications representing approximately 10% or more of the population were included in the statistical analysis. Table VII is a summary of the X^2 analysis for the above distribution. There were no significant differences between sex and test results for medical classifications. A X^2 (See Table VIII) computed for medical classification and combined test results for males and females revealed a significant difference ($P < .01$, 6 df). The significance was reflected in the "no response" category ($P < .001$, 3 df), with "encephalopathy due to post-natal cerebral infection" and "unknown prenatal influence" making up the classifications.

Table IX is a breakdown of audiometric results by ward, sex, and test results for all residents four years of age and older. Age four was chosen as it is generally felt that children of this age can be tested with a certain degree of reliability using standard audiometric techniques. A total of 97% of this population was seen. There was no significant difference between sexes for these data (Table X).

Table XI reveals the X^2 values for audiometric data <u>vs</u> gross sound data. It is obvious that there is a significant difference between the test results obtained by the two methods. The significance

TABLE V.

Variables ge - Sex - Test Results	df	X^2	Level of Significance	M	F	Total
0 - 3 years	2	1.18	NS	50	50	100
4 - 9 years	2	1.98	NS	200	171	371
10 - 19 years	2	9.31	.01	175	155	330
No responses	1	6.26	.02	3	13	16
20 - 29 years	2	1.58	NS	87	77	164

TABLE VI.

Medical Classification	Total Screened			Responded			Did Not Respond			Difficult To Test (DTT)		
	M	F	T	M	F	T	M	F	T	M	F	T
Unclassified	39	69	108	35	54	89	0	8	8	4	7	11
11	12	12	24	12	8	20	0	1	1	0	3	3
12	55	43	98	48	32	80	3	7	10	4	4	8
21 - 24	15	11	26	12	6	18	0	2	2	3	3	6
31	7	3	10	7	2	9	0	0	0	0	1	1
32	22	10	32	20	9	29	1	0	1	1	1	2
33	29	18	47	26	15	41	2	3	5	1	0	1
34	20	26	46	18	21	39	2	1	3	0	4	4
42-49	9	9	18	8	6	14	0	0	0	1	2	3
51-54	6	6	12	5	3	8	1	1	2	0	2	2
61	35	50	85	29	37	66	4	8	12	2	5	7
62	89	83	172	79	70	149	2	3	5	8	10	18
64	31	37	68	29	35	64	1	0	1	1	2	3
69	81	54	135	66	42	108	7	1	8	8	11	19
71-72	6	7	13	4	4	8	2	2	4	0	1	1
78	16	12	28	15	12	27	1	0	1	0	0	0
79	2	5	7	2	4	6	0	1	1	0	0	0

continued..

TABLE VI. (continued)

Medical Classification	Total Screened			Responded			Did Not Respond			Difficult to Test (DTT)		
	M	F	T	M	F	T	M	F	T	M	F	T
81	16	5	21	16	5	21	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0	0	0	0
84	6	1	7	6	0	6	0	1	1	0	0	0
89	46	41	87	35	31	66	3	3	6	8	7	15
Total	542	502	1044	472	396	868	29	43	72	41	63	104

TABLE VII.

Variables Med. Class - Sex - Test Results	df	X^2	Level of Significance	M	F	Total
Unclassified	2	5.24	NS	39	69	108
12	2	4.21	NS	55	43	98
62	2	1.16	NS	89	83	172
69	2	3.33	NS	81	54	135

TABLE VIII.

Variables	df	X^2	Levels of Significance	Med. Class.				
				UC	12	62	69	Total
Med. Class - Test Results	6	19.81	.01	108	98	172	128	506
Responses	3	0.31	NS	89	80	149	108	426
No Response	3	16.75	.001	8	10	5	1	24
DTT	3	2.74	NS	11	8	18	19	56
				R	NR	DTT		
Unclassified (uc)	1	1.92	NS	89	8	11	108	
12	1	9.93	.01	80	10	8	98	
62	1	1.90	NS	149	5	18	172	
69	1	5.96	.02	108	1	19	128	

was beyond the .001 level in all categories.

Tables XII and XIII are a distribution by sex, age, and medical classification of those residents who passed and failed the audiometric screening test respectively. Those residents who passed, range in chronological age from five to 39 years with a mean age of 14.1 years. Those who failed range in age from five to 37 years, with a mean age of 17.8 years. There were 13 females and 21 males who passed and 9 females and 14 males who failed. No discernible trends emerged as to medical classification for either group.

Discussion

The high percentage of residents screened (98%) probably indicates that the time chosen for testing (immediately after noon naps) was optimum and that good cooperation was obtained from institutional staff. The fact that females tended to be more difficult to test by noise-makers is not entirely clear. A number of variables could have intervened and influenced the results obtained. No explanation can be offered for the fact that females tended to be less responsive than males in the 10-19 age group.

The medical classification showing a difference as regards to less responsiveness was reflected in two categories, "encephalopathy due to post-natal cerebral infection" and "unknown prenatal influence." However, there was only one case of the latter classification that did not respond; consequently, the significance reached is probably an over generalization.

The differences between audiometric data and gross sound testing was expected. That is, one would not expect to be able to condition

TABLE IX.

WARD	TOTAL POPULATION			NOT PRESENT			TOTAL SCREENED			RESPONDED			DID NOT RESPOND			DIFFICULT TO TEST			MEDICAL CONTRAIND. TO TESTING		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Inf. 1.	53	33	86	0	0	0	53	33	86	3	3	6	0	1	1	50	29	79	0	0	0
Inf. 2.	55	44	99	0	0	0	55	44	99	3	0	3	2	0	2	50	44	94	0	0	0
Inf. 3.	31	76	107	0	1	1	30	75	105	0	1	1	1	1	2	29	73	102	1	0	1
Inf. 4.	104	0	104	2	0	2	101	0	101	2	0	2	0	0	0	99	0	99	1	0	1
Inf. 5.	25	81	106	0	0	0	25	81	106	0	1	1	4	3	7	21	77	98	0	0	0
Inf. 6.	49	49	98	0	0	0	49	49	98	2	5	7	8	2	10	39	42	81	0	0	0
Inf. 7.	34	17	51	2	2	4	31	14	45	11	3	14	0	1	1	20	10	30	1	1	2
Inf. 8.	55	56	111	1	0	1	52	55	107	0	0	0	0	0	0	52	55	107	2	1	3
I North	3	5	8	0	1	1	1	4	5	0	0	0	0	0	0	1	4	5	2	0	2
I South	10	6	16	0	0	0	10	6	16	0	0	0	0	0	0	10	6	16	0	0	0
II North	14	15	29	2	1	3	11	14	25	0	0	0	0	0	0	11	14	25	1	0	1
II South	15	4	19	0	0	0	15	4	19	0	0	0	0	0	0	15	4	19	0	0	0
III North	14	20	34	0	0	0	14	20	34	0	0	0	0	0	0	14	20	34	0	0	0
III South	11	6	17	0	0	0	11	6	17	0	0	0	0	0	0	11	6	17	0	0	0
IV North	14	25	39	0	1	1	14	24	38	0	0	0	0	0	0	14	24	38	0	0	0
IV South	15	14	29	0	0	0	15	13	28	0	0	0	0	0	0	15	13	28	0	1	1
Totals	502	451	953	7	6	13	97% 487	98% 442	97% 929	4% 21	3% 13	4% 34	3% 15	2% 8	2% 23	93% 451	95% 421	94% 872	8	3	11

TABLE X.

Variables	df	X^2	Level of Significance	M	F	Total
Sex - Test Results (Audiometrically)	2	4.29	NS	487	442	929

all residents to respond to pure tones in the short time that they were seen. It is our opinion, then, that much more time should be spent attempting to condition them or that other methods for audiometric screening would be more appropriate, which is reflected in the report by Lloyd and Reid (1967). Audiometric techniques such as modified ear choice, play, TROCA, and electroencephalic audiometry via radio telemetry (Reneau and Mast, 1968) or direct method recording (Nodar and Graham, 1968) may be more appropriate for this type of population.

The use of noise-makers with a broad frequency response and of high intensity is of questionable value. That is, these types of stimuli reveal very little, if any, information about unilateral and mild hearing losses. At best, we are aware that if an auditory sound is made loud enough a response is elicited in 83% of the population, while 7% sill not respond, and 10% will be difficult-to-test. On the other hand, audiometric data revealed 4% passed, 2% failed, and 94% were difficult-to-test.

The data collected, then, is of importance in that as a result of this initial survey, a need has been pointed up for more intensive audiometric work with this type of population. This is not to say that this fact was not evident prior to the survey. However, we felt that this should be one of the first steps in any institutional program, i.e., identification. This survey has paved the way for ear, nose, and throat examinations of all patients by an otologist. Plans are now underway to begin programming for the residents in the various test-result categories.

An examination of the data of those who passed and failed audio-

TABLE XI.

Variables	df	X^2	Level of Significance	Audio-Meters	Noise-Makers	Total Tests
diometer-Gross Sounds-Test Results	2	1435.37	.001	929	1044	1973
Passed	1	67.70	.001	34	868	902
Failed	1	20.48	.001	23	72	95
DTT	1	701.50	.001	872	104	976

TABLE XII.

Resident	Sex	Age(Yrs.)	Medical Classification(Heber,1961)
JL	M	5	69x, Unknown Prenatal Influence
CH	M	6	69x, Unknown Prenatal Influence
TL	F	6	78x, Encephalopathy associated with prematurity
RH	M	7	71x, Encephalopathy associated with diffuse sclerosis of the brain
PM	M	7	69x, Unknown Prenatal Influence
AN	F	7	34.2, Hematoma of brain
DB	M	8	64x, Mongolism
MM	M	8	81x, Cultural-familial
JW	F	8	62.2, Hydrocephalus, congenital
AB	F	9	69x, Unknown Prenatal Influence
JB	M	9½	62.2, Hydrocephalus, congenital
JF	M	9	61x, Cerebral Defect, congenital
LH	F	9	69x, Unknown Prenatal Influence
GL	M	9	34x, Encephalopathy due to postnatal injury
SM	M	9	33x, Encephalopathy due to anoxemia at birth
RP	M	10	62.2, Hydrocephalus, congenital
CZ	F	10	62.2, Hydrocephalus, congenital
KD	M	11	69x, Unknown Prenatal Influence
RR	M	11	81x, Cultural-familial
LH	M	15	69x, Unknown prenatal influence
MS	F	16½	61.4, Multiple congenital anomalies of brain
WF	M	18	62.2, Hydrocephalus, congenital
RH	M	18	12x, Encephalopathy due to postnatal infection
GW	M	19	33x, Encephalopathy due to anoxemia at birth
WF	M	20	81x, Cultural-familial
ES	M	20	81x, Cultural-familial
FS	F	21	33x, Encephalopathy due to anoxemia at birth
DW	F	21	89x, Uncertain cause with functional reaction alone manifest
DK	F	23	61x, Cerebral defect, congenital
BS	F	24	34x, Encephalopathy due to postnatal injury
KA	F	27	34.2, Hematoma of brain
EM	M	28	81x, Cultural-familial
CS	F	33	89x, Uncertain cause with function reaction alone manifest
FF	M	39	81x, Cultural-familial

TABLE XIII.

Resident	Sex	Age(Yrs.)	Medical Classification (Heber, 1961)
DB	F	5	33x, Encephalopathy due to anoxia at birth
GL	F	7	89x, Uncertain cause with functional reaction alone manifest
GH	M	8	62.5, Microcephaly, primary
JB	F	8	62.5, Microcephaly, primary
DR	M	11	64x, Mongolism
JS	M	11	64x, Mongolism
WW	M	12	64x, Mongolism
PS	M	12	32x, Encephalopathy due to mechanical injury at birth.
HG	M	13	62.5, Microcephaly, primary
LS	F	14	12x, Encephalopathy due to postnatal cerebral infection
PB	F	17	64x, Mongolism
MB	M	18	62.2, Hydrocephalus, congenital
SH	M	18	64x, Mongolism
MR	F	18	43.2, Hematoma of the brain
ML	M	19	69x, Unknown Prenatal influence
AM	F	22	64x, Mongolism
JW	F	23	12x, Encephalopathy due to postnatal cerebral infection
LL	M	26	89x, Uncertain cause with function reaction alone manifest.
RS	M	27	81x, Cultural-familial
MG	M	27	12x, Encephalopathy due to postnatal cerebral infection
LS	M	28	32x, Encephalopathy due to mechanical injury at birth
IJ	M	29	21x, Encephalopathy, congenital, associated with toxemia of pregnancy
AC	F	37	64x, Mongolism

metrically did not reveal a noticeable trend as to sex, age, or medical classification. This finding may be a reflection of the small sample. It is interesting to note that all residents who failed via the audiometer passed by gross sound testing.

Major conclusions drawn from this hearing survey are:

(1) It is possible to conduct a hearing survey of a severely and profoundly mentally retarded institutionalized population,

(2) There were more females that were difficult-to-test, especially in the 10-19 age group,

(3) No relationship was found between medical classification using the present testing methods,

(4) An audiometer by itself is probably not the best tool to audiometrically screen a severely and profoundly mentally retarded population,

(5) Gross sounds will miss unilateral and mild hearing losses,

(6) One should apply other methods of testing with such a population, e.g., modified ear choice, play, TROCA, and electroencephalic audiometry, and

(7) A screening survey does provide basic information about a severely and profoundly mentally retarded population for planning further clinical and research activities in hearing.

Summary

An audiometric survey was conducted among an institutionalized severely and profoundly mentally retarded population in order to obtain basic information for planning further clinical and research activities. A total of 1,044 residents were seen for gross sound testing while 933 (4 years and older) of these were screened by using an audiometer. The percentage responding to gross sounds was 83%, those not responding was 7%, and 10% were found to be difficult-to-test. On the other hand, using an audiometer, only 4% passed, 2% failed, and 94% were difficult-to-test. Advantages and disadvantages using both methods are discussed. A screening survey does provide basic information about a severely and profoundly mentally retarded population for planning further clinical and research activities in hearing.

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